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TESTING PARTIAL ATMOSPHERIC FUMIGATION FOR ERADICATING EUROPEAN PINE SHOOT MOTH ON BALED AND BAGGED PINE SEEDLINGS

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by

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SUMMARY

Partial atmospheric fumigation with methyl bromide was tested as a means of eradicating European pine shoot moth on baled and bagged ponderosa pine seedlings. Preliminary results show that, with overwintering larvae, treatment periods can be reduced at least 30 percent, as compared with conventional atmospheric fumigation, and still result in 100-percent shoot moth control. Judging from larval mortality, both baled and bagged seedlings can be effectively treated by partial atmospheric fumigation during the dormant period with minor damage resulting.

INTRODUCTION

Studies in the Seattle, Wash., area during 1960-61 showed atmospheric fumigation with methyl bromide to be effective in eradicating European pine shoot moth on ornamental pines growing in the ground or in containers. Inexpensive, portable fumigation chambers were developed and standard fumigation procedures were devised whereby 100-percent kill of the shoot moth can be obtained under widely varying out-of-door conditions. These standard procedures were incorporated in shoot moth quarantines of the Federal Government and of several Western States.

In 1961-62, the fumigation method was tested on ponderosa pine planting stock, chiefly for phytotoxicity, in a forest nursery of the Washington Department of Natural Resources. Seedlings in beds were fumigated in midwinter. Seedlings in bales, held up to 3 months in cold storage, were treated monthly from December until April. Outplanted seedlings from the

fumigated bales showed little damage, but this was not conclusive because penetration of the methyl bromide into the bales may not have been adequate for complete kill of the shoot moth. Larvae of the moth were not introduced into the bales, since the test nursery was in a shoot moth-free zone. In general, the method of outdoor treatment was not entirely satisfactory for baled stock because of the limited capacity of the portable chambers and the difficulty of controlling temperatures within prescribed limits at this time of year.

A method of packaging conifer planting stock, devised by Duffield and Eide,[1/] is likely to replace baling. The new method has advantages in shipping and handling, but its adaptability to fumigation has not been explored. A 3-ply multiwall kraft bag is used. The inner wall is a 10-pound polyethylene laminate on 50-pound kraft paper and the outer wall, 50-pound, wet-strength kraft. Bunches of 50 seedlings each are placed in the large bags alternately, with roots of one bunch lining up with tops of another bunch. Rotted wood chips or peat may be placed on the roots, but this is not necessary. Bag tops are sealed by wrapping and tying or folding and stapling.

Partial atmospheric fumigation, also called vacuum fumigation, was suggested by J. R. Fisher[2/] as a possible means of treating both baled and bagged stock. This method, which requires large permanent chambers properly equipped, is said to result in gas penetration superior to that of atmospheric fumigation. By treating in large quantities, this method promises cost savings in comparison with treatment in portable chambers. However, there is a possibility that fumigation by partial vacuum would increase the risk of damage to the trees. The method is used by Federal Plant Quarantine offices at some ports of entry, and recommendations for treatment time at a given chamber temperature are quite similar to those derived in the Seattle tests. At ports of entry, survival of plants is considered secondary to the destruction of noxious insects present.

A cooperative study by the Pacific Northwest Forest and Range Experiment Station, Portland, Oreg., and the Dow Chemical Co., Seattle, Wash., was initiated in the spring of 1963 to explore the capabilities of vacuum fumigation.[3/] Station personnel planned the experiment, obtained a supply of shoot moth infested twigs for testing purposes, made records during

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1/ Duffield, J. W., and Eide, R. P. Polyethylene bag packaging of conifer planting stock in the Pacific Northwest. Jour. Forestry 57(8): 578-79. 1959.

2/ Entomologist, Research and Development, The Dow Chemical Co., Seattle, Wash.

3/ Memorandum of Understanding for Forest Insect Research, dated March 14, 1963.

the testing, provided for examination of treated material, and interpreted the results. The Dow Chemical representative arranged for the use and operation of fumigation chambers, obtained the desired number of packages of ponderosa pine seedlings through the Washington Department of Natural Resources, provided the fumigant, and insured that fumigation instructions were followed by the commercial operator. The Ruddy Fumigant Co. in Seattle, Wash., provided the chambers for the tests and operated the equipment.

OBJECTIVES

This study was to compare the efficiency of partial atmospheric fumigation with that of atmospheric fumigation in obtaining 100-percent control of the shoot moth when seedlings were dormant and larvae inactive. Specific objectives were to determine for partial atmospheric fumigation whether:

1. Complete control can be obtained in shorter treating time than with standard atmospheric fumigation.
2. Complete control can be obtained both in baled and packaged pines.
3. Damage to trees differs in comparison with atmospheric fumigation.

METHODS

Partial atmospheric fumigation is accomplished by creating a partial vacuum, introducing the gas, and then releasing the vacuum. A 15-inch (approximately 50 percent) vacuum was used in these tests. With the chambers used, 7 to 8 minutes were required to obtain the desired vacuum, 2 to 3 minutes to introduce the gas, and about 5 minutes to release the vacuum. Treatment time was construed to start after release of the vacuum and to end at the beginning of gas evacuation.

The actual fumigation was done on March 14 and 15, a relatively cool period, in an unheated warehouse. Chamber temperatures ranged from 42° to 50° F., except for a brief period during and immediately after gas introduction. Temperatures were depressed when the vacuum was drawn but rose when the vacuum was released. Starting temperatures after release of the vacuum were usually about 6° above original chamber temperatures, but return to original chamber temperatures took place within 5 to 10 minutes.

Gas concentration was 4 pounds per 1,000 cubic feet. The large, cylindrical, metal chambers, relics of Prohibition days, were of 1,800-cubic-foot capacity, so that 7.2 pounds of actual fumigant were used in each chamber. Gas was circulated by means of one fan placed on the floor toward the rear of the chamber near the gas inlet.

Five test runs, each consisting of two chambers, were made. Runs were designated as A to E. In four runs, partial atmospheric fumigation was used in both chambers. Treatment time in one chamber in each run was "standard," as derived from tables of temperature and time prepared for atmospheric fumigation in previous studies. Treatment time in the second chamber was reduced; percent reductions from calculated standard treatment time by test run were: A-20, B-22½, C-25, and E-30. In the remaining test run (D), atmospheric fumigation was used in one chamber and partial atmospheric fumigation in the other; treatment time was standard according to tables for atmospheric fumigation and identical for the two chambers.

The pine material used in each test run was packaged in four different ways:

1. Standard bale with 1,000 2-0 ponderosa pine seedlings.
2. Large kraft bag with 1,000 2-0 ponderosa pine seedlings.
3. Small kraft bag with 100 2-0 ponderosa pine seedlings.
4. Control group of infested twigs of Scotch, mugho, or Monterey pine, anchored in sand in clay pots.

Packages in categories 1, 2, and 3 were "salted" with infested bud clusters from twigs collected at 13 points on Mercer Island, Wash., on March 13. Bud clusters on a short section of twig were systematically placed in different positions in the bales and bags. Numbers of bud clusters used for each kind of bundle were: (1) standard bale, 40; (2) large bag, 40; (3) small bag, 10; and (4) control twigs, 27 to 35.

Location and tree species from which infested bud clusters were collected were replicated by category of package in the two chambers used in a test run. This was done to equalize any differences in natural mortality associated with tree source. Table 1 shows the distribution of the infested samples within the test material.

Percent larval mortality was used as index of fumigation success. After each test run, fumigated bales and bags were opened and all bud clusters removed. These bud clusters and infested twigs from the clay pots were placed in separate polyethylene bags according to test run, chamber number, and category of package. During the next two weeks, all bud clusters were opened under a binocular microscope and the condition of each larva was recorded as living or dead.

Incidence of damage to the seedlings was sampled by taking 10 fumigated trees from each bale and each large bag and planting them on the property of J. R. Fisher. The planting site was previously rototilled five times to a 6-inch depth until grass was completely removed. Trees were planted on March 17 in rows of 10 trees running north and south, and 20 rows running east and west, totaling 200 trees. Tree survival was recorded in detailed examinations on August 6, 1963, and April 13, 1964.

Table 1. Distribution of infested bud clusters among packages of pine material fumigated in five test runs, 1963

Test run and treatment time and package category	Pine species	Collection point	Bud clusters per chamber
			Number
A, chamber 1 (standard) and chamber 2 (reduced 20 percent):			
Bale	Mugho	1	25
Bale	"	2	15
Large bag	"	3	20
Large bag	"	4	20
Small bag	"	5	10
Twigs	"	5	10
Twigs	"	6	20
B, chamber 1 (reduced 22½ percent) and chamber 2 (standard):			
Bale	Mugho	5	40
Large bag	"	5	25
Large bag	"	7	15
Small bag	Scotch	8	10
Twigs	"	8	27
C, chamber 1 (standard) and chamber 2 (reduced 25 percent):			
Bale	Mugho	9	40
Large bag	"	9	40
Small bag	"	5	10
Twigs	Scotch	10	35
D, chamber 1 (standard) and chamber 2 (standard):[1/]			
Bale	Scotch	10	40
Large bag	"	10	40
Small bag	"	11	10
Twigs	"	11	30
E, chamber 1 (standard) and chamber 2 (reduced 30 percent):			
Bale	Mugho	5	5
Bale	"	9	15
Bale	Scotch	10	20
Large bag	"	11	15
Large bag	Mugho	12	25
Small bag	"	9	2-3
Small bag	Scotch	10	8-7
Twigs	"	10	18
Twigs	Monterey	13	12

1/ Conventional atmospheric fumigation was used in chamber 1, partial atmospheric fumigation in chamber 2. Treatment times were identical.

RESULTS

The relatively low chamber temperatures resulted in lengthy treatment periods, up to 3 hours and 31 minutes for standard treatments. Reductions in treatment time ranged up to 59 minutes for a 30-percent time reduction. Results by test run and chamber are summarized in Table 2.

Complete kill of all European pine shoot moth larvae was obtained in all test runs, regardless of reduction in treatment time, and with all types of packages. A total of 905 dead larvae was found (table 3).

Analysis of tree damage was confounded by mortality caused by the dumping of weed killer in the planting area 2 years previously. However, since not more than five trees from any bale or bag were in the contaminated area, conclusions were drawn from the remaining trees. Damage was defined as death of seedlings or failure to produce current growth. With partial atmospheric fumigation at standard treatment time, no difference in damage between baled and bagged seedlings was evident. On August 6, average survival was 91 and 93 percent, respectively. At reduced treatment time, average survival of baled and bagged seedlings was 87 and 100 percent, respectively. The 20 trees treated with standard atmospheric fumigation showed no damage. On April 13, examination showed essentially no change in the area uncontaminated with weed killer, with three more trees showing damage and one recovering from damage. In the contaminated area, many damaged trees were missing and four additional trees showed damage.

CONCLUSIONS

The test resulted in the following general conclusions:

1. With overwintering larvae, treatment periods using partial atmospheric fumigation can be reduced at least 30 percent, as compared with conventional atmospheric fumigation, and still result in 100-percent control of shoot moth larvae. Minimum effective treatment periods remain to be determined.

2. Judging from larval mortality, both baled or bagged pine seedlings can be effectively treated by partial atmospheric fumigation.

3. Tree damage resulting from partial atmospheric fumigation during the dormant period is minor. Damage to trees in bags, with little protection to roots, is no greater and probably less than damage to baled trees.

Table 2.--Summary of shoot moth survival and seedling damage resulting from partial atmospheric fumigation, Seattle, Wash., March 14-15, 1963

Test run	Treatment time	Fumigation exposure			Shoot moth larvae		Trees planted[1]	
		Duration		Temperature range	Total	Surviving	Total	Undamaged
		Hrs.	Min.	Degrees F.	Number		Number	
A, chamber 1	Standard	3	24	46-48	93	0	20	16
A, chamber 2	Reduced 20 percent	2	43	46-48	122	0	20	19
B, chamber 2	Standard	3	12	48-50	108	0	18	17
B, chamber 1	Reduced 22½ percent	2	29	48-50	116	0	10	7
C, chamber 1	Standard	3	14	48-50	97	0	10	9
C, chamber 2	Reduced 25 percent	2	29	48-50	90	0	14	14
D, chamber 2	Standard	3	31	44-45	54	0	20	19
D, chamber 1	Standard[2]	3	31	44-45	63	0	20	20
E, chamber 1	Standard	3	15	47-53	83	0	20	19
E, chamber 2	Reduced 30 percent	2	16	47-53	79	0	20	19
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[1] Excluding trees planted in area contaminated with weed killer.

[2] This was the only treatment in which conventional atmospheric fumigation was used.

Table 3.--Larvae found in packaged material, by test run and treatment time, 1963[1/]

Packaged material	Test runs									
	A1	A2	B1	B2	C1	C2	D1	D2	E1	E2
1,000-tree bales	25	34	39	45	33	30	12	14	26	30
1,000-tree bags	28	30	47	33	26	26	19	14	21	22
100-tree bags	8	14	8	6	14	20	4	3	6	5
Infested twigs	32	44	22	24	24	14	28	23	30	22
Total	93	122	116	108	97	90	63	54	83	79

[1/] Number "1" designates standard treatment time.

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